

## DMR Notes

---

### DISCLAIMER:

*The follow text was extracted from SAGE-III DMR by David Lassiter, 757-824-2137, <David.J.Lassiter.1@gsfc.nasa.gov>, and is intended as quick reference only. The DMR itself is the official document.*

---

## Detailed Mission Requirements (DMR) Document for Stratospheric Aerosol and Gas Experiment (SAGE) III

**Date:** April 24, 1996

### 1010 Approval Authority

- Project Center
  - Prepared by:
    - Angelita C. Kelly, Code 505, EOS Mission Operations Manager (MOM), Earth Science Data and Information System Project
  - Approved by:
    - Mark Fortaine, Code 170, Deputy Director/Resources, Mission to Planed Earth
    - L.I. Mauldin, III, SAGE III Project Manager
    - Dr. M. Patrick McCormick, SAGE III Principal Investigator
- Lead Center
  - Code 500 Response Prepared by:
    - John P. Lynch, Code 553, Flight Dynamics Engineer
  - Code 500 Approved by:
    - Arthur J. Fuchs, Director of Mission Operations and Data Systems
  - Code 800 Response Prepared by:
    - Alan R. Selser, Code 823.3, Head, RF Tracking and Digital Systems Section
  - Code 800 Approved by:
    - Arnold L. Torres, Director of Suborbital Project and Operations

### 1100 Project Description

- Stratospheric Aerosol and Gas Experiment (SAGE) III
- Limb scanning spectrometer, 1-2 kilometer resolution
- Instrument 100 kbps data rate, daily average about 24 kbps
- Flown on Russian Meteor-3M spacecraft
- Orbit parameters
  - sun synchronous
  - 1020 kilometer altitude
  - 99.65 inclination
  - ascending node crossing 9:15 AM +/- 5 minutes local mean solar time
- Data transmitted to both Russian and US data stations twice every 24 hours

### 1110 Experiment Description

- Improved extension of Stratospheric Aerosol Measurement II (SAM II), SAGE I and SAGE II
- O<sub>3</sub>, H<sub>2</sub>O, NO<sub>2</sub>, NO<sub>3</sub>, OClO

- Goals:
  - Retrieve global profiles
  - Investigate spatial and temporal variability
  - Characterize tropospheric and stratospheric aerosols and clouds
  - Extend SAM II, SAGE I and SAGE II solar occultation data sets
  - Provide atmospheric data essential for calibration of other satellite sensors

### **1130 Mission Operations Concept**

- Forward Link
  - Russian Space Agency (RSA), Meteor 3M control center, Kaliningrad, Russia responsible for transmitting commands.
  - During routine operations, commands transmitted once every 2 weeks; with additional support available if needed
  - NASA SAGE III operations center at LaRC develops command loads, sent to Meteor 3M control center via Internet or other
  - Operational timelines, command formats and detailed operations plans documented in jointly developed Meteor 3M/SAGE II Mission Operations Plan. Meteor3/TOMS mission operations are used as a "blueprint"
- Return Link
  - Similar to Meteor 3/TOMS: identical sets of instrument data relayed 2/day to ground stations in Dolgoprudny, Russia and WFF. WFF is responsible for data reception, archival of raw data for at least two weeks, data quality monitoring and supporting data transfers to LaRC.
  - Upon receipt at WFF, raw SAGE data is automatically transferred to the SAGE III operations center for Level 0 processing. L0 data is checked at the SAGE III operations center for instrument health, safety and that performance parameters are within limits.
  - SAGE III housekeeping data is monitored by RSA Meteor 3M control center in Kalinigrad, Russia. In event of malfunction, ground controllers perform contingency procedures and notify SAGE III LaRC. Feasibility of transmitting SAGE housekeeping data in real time to the SAGE III operations center at LaRC via the Internet is being explored.
- Flight Operations
  - Planning: Basic plan is to obtain solar and lunar occultation data whenever geometry permits and instrument health/safety is not compromised. Flight software designed for near autonomous operations.
  - Execution: SAGE II operations center will verify that instrument is performing as planned and that L0 data is transferred to LaRC DAAC and SAGE III SCF.
  - Analysis: Scientists and software developers to determine that maximum data yield and instrument effects on data are understood. Trend analysis is carried out on a monthly basis. Performance changes are noted and mitigated.
- Mission Support Activities
  - ESDIS project will provide link operations and data transfer links between LaRC and WFF. Definition, development support, maintenance and testing between U.S. and Russia will be conducted by ESDIS.
- Summary
  - Operations concept for this DMR has been extracted from SAGE III Mission Operations Concept, which should be referred to for further details.

### **1140 Planned Mission Milestones**

- Shows launch date of 1-Aug-98 with 5 year on-orbit operations
- Quarterly interface meeting though launch + 3 months

### **2000 Radio Frequency (RF) Telecommunication - Requirements**

- Downlink only during normal on-orbit phase. See sections 2005 and 2020 for details.

### **2005 Radio Frequency (RF) Telecommunication – Summary Tables**

- Communications support is thought WFF, downlink only, 2x per day to capture 24 hours of science and housekeeping data.
- 1704.3384 MHz, PM, Bi-phase L, 665.4 kbps (Instrument Telemetry, SAGE III recorded data)

### **2020 Radio Frequency (RF) Telecommunication – Telemetry Frame Structure**

- Uses CCSDS Transfer Frame (shown in diagram form, no detail to know frame length, version #, etc.)

### **2400 Wallops Flight Facility (WFF) Requirements - Summary**

- WFF to support two, twelve minute nominal contacts per day, approximately 12 hours apart.
- Downlink only.
- Contact consists of data played back from LaRC recorder.
- Data to be captured and forwarded to LaRC.
- LaRC to provide schedule and acquisition data to WFF.

### **2420 Wallops Flight Facility (WFF) Requirements – Downlink**

- Downlink is SAGE III instrument playback at 665.4 kbps, PM carrier at 1704.3384 MHz with Bi-phase L coding. Site acquisition data will be provided by LaRC.
- Wallops shall implement:
  - Interface to standard Internet Protocol
  - Data Quality Monitoring
  - Store and forward data to LaRC.
  - Archive raw data for a minimum of 14 days.

### **3000 Testing and Training Requirements**

- Data flows, operations exercises and simulations will be conducted between WFF and LaRC
- A SAGE III data simulator or electronic file will be used as data source for interface tests
- Station compatibility will be shown using WFF station equipment and a Russian Engineering Test Unit (ETU), which emulates actual S/C output.
- Actual recorded SAGE III telemetry or simulated telemetry will be provided to the ETU by LaRC.

### **3100 Compatibility Testing**

- Intended to assure RF link between flight hardware and ground equipment.
- Output of ETU connected to test inject of WFF antenna. Downlinked signal is received, demodulated and processed by WFF equipment and evaluated for thresholds and data accuracy.

### **7000 Trajectory and Attitude Support Requirements Summary**

- Flight Dynamics will provide trajectory support for the mission, providing:
  - Pre-mission coordination
  - Software to SAGE III Project for determination of orbit, propagation, and acquisition data generation
- There is no attitude support required for FDF

### **7200 Trajectory Requirements**

- FDL will:
  - Develop and install orbit determination and propagation software on LaRC equipment to process GPS/LSONASS state vectors, perform least squares orbit determination to accuracy of: 500 m along track, 250 m radial, and 1000 m cross track
  - Provide on-orbit validation of GPS/LSONASS state vectors

- Develop and install acquisition data generation on software on LaRC equipment to generate ephemeris and IIRV's to be transmitted to WFF

Return to [TOP](#) of document

## MISSION REQUIREMENTS REQUEST

Requesting Agency: Office of Mission to Planet Earth (Code Y)  
Contact: Victoria Hall, Program Manager  
Category: NASA Cooperative  
Objectives: Measure profiles of aerosols, ozone, water vapor, nitrogen dioxide and trioxide, temperature, pressure and chlorine dioxide using the solar and lunar occultation techniques.

- Launch Information

Type: Expandable launch vehicle  
Vehicle: Zenit-2  
Launch Site: Plesetsk, Russia  
Trajectory: Injection into low earth orbit  
Launch Date: August 1, 1998 (target)

- Key Mission Events and Dates

Critical Phase: Launch to L+< 1 day (establish communications, deploy solar array, thermal control)  
Early Orbiting Phase: end of critical phase to 90 days  
Normal Operations: from EOP to end of mission  
Mission Duration: Prime - 5 years  
Extended - Life of instrument and spacecraft

- Other Information

Approved Mission Start Date: November, 29, 1994  
C/D Phase Start Date: November, 29, 1994  
Present Phase (A..K) C/D  
Requirements maturity: >80%  
Funding Approval Status: Russian Spacecraft, NASA SAGE III  
Mission Lead Center: GSFC  
Project Manager: SAGE III, Ed Mauldin

- General Requirements Request:

Network: WFF, Orbital

- Mission Operations Concept Related to OSC Capabilities

Mission Control Center Location: Kaliningrad, Russia  
Remote Science Center: Langley Research Center  
Data Archives: Level 0 – Level 2 Data – EOSDIS

- OSC Data Transport Facility Requirements

OSC-Provided POCC: No

- Flight Dynamics Requirement

1. Definitive orbit analysis .. utilize Meteor 3M on-board GPS/GLONASS receiver (on reading per orbit) .. support GPS/GLONASS on-orbit accuracy validation
2. Provide consultation as necessary .. currently SAGE II receiving excellent support .. POC John Lynch

## WALLOPS FLIGHT FACILITY REQUIREMENTS

Sites: Wallops

- Telemetry Requirements

Frequency	1704.3384
BW	665.4 kbps (data rate)
Modulation	Split Phase
Subcarrier	None
Data Type	Bio-L
Format	PCM
Command Requirements	None
Radar	No
Data Communications	TCP/IP between WFF and LaRC
Pre-mission support	Compatibility Test at about L-6 months, at WFF, one week duration

- Non-NASA Facilities Request

Source/Agency	RSA/Russia
Requested Sites	Russia
Requested Services	(1) Planning scheduling data (2) Housekeeping data

- Notes

1. NASCOM Requirements: Request assessment of links between WFF and LaRC to ensure data transfer of approximately 60 Mbytes can be accomplished within one hour (to be reviewed) after reception at WFF.

Return to [TOP](#) of document